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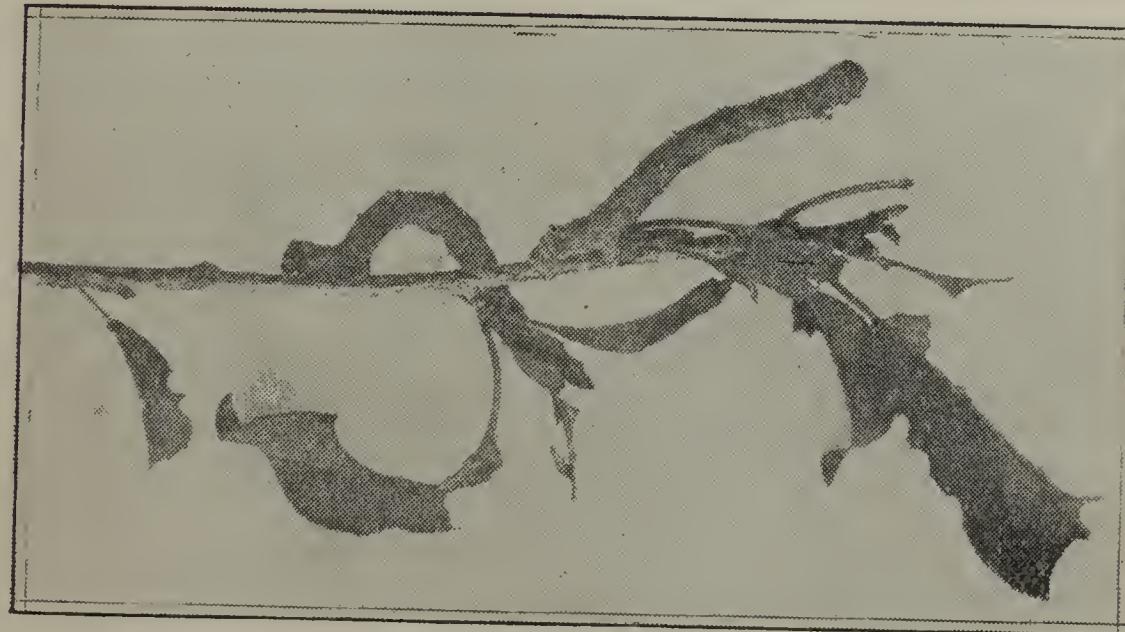
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Bulletin No. 48.

January, 1898.

OREGON AGRICULTURAL

Experiment Station



SPRAYING.



The Bulletins of this Station are sent Free to all Residents of Oregon who request them.



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SPRAYING.

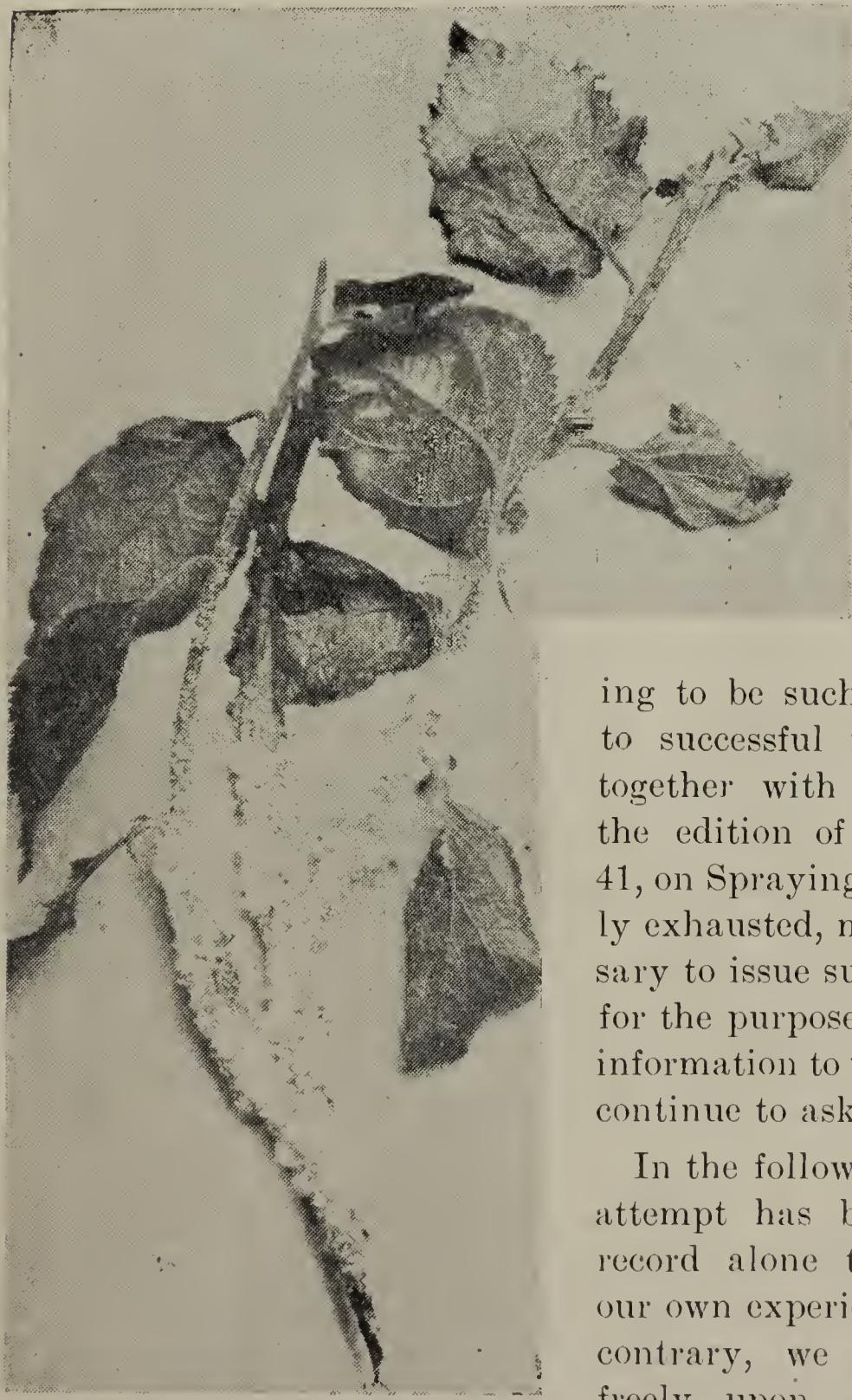
Previous bulletins of this Station, the horticultural and agricultural press, and the publications of the State Board of Horticulture,

have so widely disseminated information regarding spraying operations that another bulletin on the subject may seem almost superfluous. But the fact that spraying is coming

to be such an essential to successful fruit culture, together with the fact that the edition of Bulletin No. 41, on Spraying, is completely exhausted, makes it necessary to issue such a bulletin for the purpose of supplying information to those who still continue to ask for it.

In the following pages no attempt has been made to record alone the results of our own experience. On the contrary, we have drawn freely upon all available

sources--the horticultural press, the bulletins of other stations, the publications of the United States Department of Agriculture,



and the experience of local fruit growers, as well as our own experience, but have endeavored to select and to recommend only those thoughts and operations which our experience and observations during the past two years have convinced us are most valuable under the conditions prevailing in this State.

IMPORTANCE OF SPRAYING.

We do not believe that spraying is the one essential—or even the most essential—requisite to successful fruit culture. We do not even believe that it is the only means that should be employed to hold in check the numerous insect and fungus pests of cultivated crops. But we do believe that in this age of the codling moth and apple scab, of woolly aphis and apple canker, San Jose scale and brown rot, he is wise who *insures* his fruit and trees against the ravages of these pests by a judicious use of the spray pump.

We believe that everyone who owns an apple tree, a pear tree, a cherry tree, a fruit tree of any kind, should spray that tree or cut it down. We believe this because observation has convinced us that there are indeed few fruit trees that are not infested with some form of insect pest or fungus disease, and every infested tree that remains standing and neglected is a constant menace to the many valuable orchards of the State. This obligation should rest not alone upon those who are in the business of fruit growing. It should apply as well to the farmer who grows fruit only for family use, and to the dweller in town or city who grows only a few trees in the back yard or on a vacant lot. It should apply with particular force to the two last classes. The progressive horticulturist knows that the health, even the life of his trees, the quality of his fruit, and hence the degree of his success, oftentimes depends on a right use of the spray pump.

WHY WE SHOULD SPRAY.

Knowing that he had dealt extensively in Rogue River apples the past season, I wrote Hon. H. B. Miller of Eugene for an estimate of the loss sustained by the fruit growers of Oregon through the ravages of fruit pests. No better argument in favor of a widespread use of the spray pump can be advanced than his reply which is as follows:

"In the district where we packed nearly forty carloads of apples the *pack did not average over fifty per cent. of the fruit picked.* This was in Jackson and Josephine counties.

"The greatest damage was caused by the codling moth, but I also found a few orchards that had been great producers almost ruined by CANKER, and many other valuable orchards almost ruined by San Jose scale. The entire crop of several orchards, with a thousand bushels each of otherwise fine apples, was worthless because of scale. It is quite safe to say that in the Rogue River country alone the loss of fruit from moth and scale equalled fifty thousand dollars, and the work of the codling moth and the apple scab throughout the Willamette valley is so bad that not one-tenth of the apples are marketable. I believe it a very moderate estimate of the loss in this State this year from scale, moth and scab to place it at one hundred and fifty thousand dollars.

"The limited amount of spraying was a great surprise to me. *I am firmly convinced that two-thirds of the orchards now bearing good fruit will be worthless within five years because of failure to spray."*

WILL SPRAYING PREVENT THIS LOSS.

Nearly everyone is aware of the serious losses caused by the ravages of insects and fungi, but all are not convinced that spraying will prevent this loss. Some are skeptical because they have sprayed their trees and have seen no beneficial results, but most are skeptical because it is easier to doubt and lose their fruit than it is to dispel their doubt and save their fruit by an intelligent use of the spray pump.

It is generally admitted that eastern fruit growers may use the spray pump advantageously, and that even in this State experimental spraying may be successful. The belief seems to be quite general, however, that our excessive rainfall during the spring months is an important factor in making spraying on a large scale ineffectual in this State. I have therefore thought best to supplement our own experience with that of a few prominent fruit growers in various parts of Oregon.

Mr. C. E. Stewart, of Medford, one of the most extensive growers of apples and pears in Oregon, writes as follows:

"I have failed to make a memorandum of dates but sprayed just as soon as the blossoms dropped from the fruit and *before*

the calyx closed. The second spraying was three weeks after the first and the third spraying three weeks after the second. (This last spraying did little good as a heavy rain washed most of it off). The fourth spraying was commenced July 5th.

"Up to this time there was no wormy fruit in the orchard, but about the 20th I found some worms and many eggs on the outside rows on three sides of the orchard. Put in one day spraying them. The result was that at picking time the Bartletts, Howells, Clairgeaus and Winter Nelis were practically clean, there being not more than one-half of one per cent. wormy *except on three Bartlett trees on which the first spraying was omitted* to test the value of early treatment, but which were sprayed like the others the balance of the season. The fruit on these three trees at picking time was fully fifty per cent. wormy.

"I tried the same experiment on apples during the summer of 1896 with the same result. The per cent. of apples saved this year is fully ninety-five, and the loss nearly all occurred on outside rows where the moths came in from unsprayed orchards.

"I have a young apple orchard of eleven acres that commenced bearing last season and which was not sprayed. It is three-fourths of a mile from the main orchard and one-half mile from any bearing apple or pear trees. The fruit in this orchard was nearly all wormy. I took thirty-two wormy apples out of forty-eight from one tree in July.

"The spray I used this season and last consisted of one-half pound of Paris green, one-half pound of London purple, and four or five pounds of lime to one hundred and sixty gallons of water for the first two sprayings. For the third and fourth sprayings, fourteen ounces of Paris green and London purple were used with the same amount of lime and water as for the first sprayings. This solution may appear too strong for the last treatment, but if it is kept thoroughly stirred, *which is imperatively necessary to obtain good results*, it will injure neither fruit nor foliage.

"I think that as a rule three sprayings are sufficient if rain does not interfere and if there are no neglected orchards near."

Mr. A. Holiday of Scappoose sent us the samples of sprayed and unsprayed apples (See plate I), and wrote as follows:

"The unsprayed apples were gathered from old trees that have never been sprayed, and I think it safe to say that five-sixths of

the apples were affected with scab. The sprayed fruit was taken from trees eight or nine years old that have had good care. Having never sprayed for scab alone, last spring just before the buds opened we gave the trees a spraying with Bordeaux mixture and the result was we had very little fungus, where the year before some of the fruit was badly affected.

"We paid one dollar per barrel for lime and five dollars per hundred for blue vitriol which made the cost of material about one and one-half cents per gallon. Two gallons of spray will cover quite a large tree, and when we take into consideration that at present nice smooth apples will bring one dollar per box, while inferior stock finds slow sale for less than half that amount, I think it pays to spray."

Mr. J. M. Wallace who has extensive apple and pear orchards near Salem and who closely followed our advice in spraying adds the following testimony:

"I sprayed our pears three times with the Bordeaux mixture. The two last times I added Paris green to the Bordeaux for codling moth. The spraying was a decided success. My pears were clean, free from spots, clear of fungus and in the market sold at the top price.

"Our Spitzenburg orchard of 2,700 trees we did not spray for the codling moth as our foreman thought there were not enough apples on the trees to justify the expense. There were, however, three or four hundred bushels, out of which we got 30 boxes free from worms, which sold for one dollar per box. The remainder we sold at the cider mill for thirty cents per bushel. This experience speaks for itself."

FAILURES.

The above examples are sufficient to prove that spraying is a success if intelligently and energetically done, even in Oregon. Still, many have sprayed, have seen no beneficial results from the application and have condemned the process as worthless. To such we would say study thoroughly the cause of your failure and then try again. Blame yourself for your failure--do not condemn a process that has been proven to be a success by thousands of practical men in most of the principal fruit growing regions of the world. The cause of your failure was probably one of the following causes:

- 1st. The use of the wrong remedy.
- 2d. The use of poor materials.
- 3d. Lack of thoroughness in spraying.
- 4th. Spraying at the wrong time.
- 5th. Failure to spray often enough.

We will briefly consider each of these points in succession.

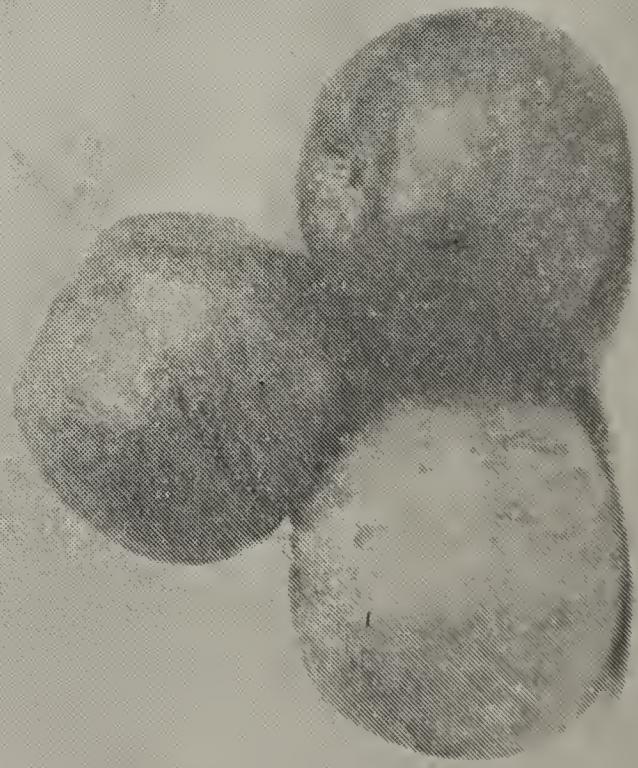
First. Do not spray because spraying in general is a good thing or because some one has succeeded in saving their crops by spraying. Study the pests infesting each variety of fruit in your orchard and then apply the proper remedies for those particular pests. Do not go into your orchard with a spray pump until you know why you are to spray, what you should use, and how best to apply it. In case of doubt on any of these points apply to the Station for further information.

Second. Unfortunately, much of the materials used in spraying is adulterated, and will give poor results no matter how thoroughly and intelligently they are used. This is really a serious matter since one not only loses the amount paid for the materials, but loses the expense incurred in applying the sprays, may lose a large portion of his crops, and is likely to lose his faith in all spraying operations. The fruit growers of the State should unite in securing the passage of a law imposing a heavy fine for the sale of any adulterated spraying materials. All that can be done at present is to require a guarantee that the materials are reasonably pure, and in case of doubt to send samples of the material to the Station for analysis.

Third. Slipshod work in spraying can not be too strongly condemned, and yet it is very common. Last season I passed some trees, not far from the Station buildings, that had recently been sprayed with Bordeaux mixture and on which the marks of careless work were everywhere apparent. Instead of being covered uniformly with a delicate blue tint, these trees looked as though a fresco painter had attempted to paint designs in blue upon their green foliage. Not more than one-half of the leaves had been touched by the spray. "Squirting a few quarts of water upon a tree as you hurry past is not spraying. A tree is honestly sprayed when it is wet all over, on all the branches and on both sides of the leaves. An insect or fungus is not killed until the poison is placed where the pest is. Bugs do not search for poison." Thoroughness in spraying then consists in getting the

UNSPRAYED.

SPRAYED.



mixture evenly distributed over every part of the tree. It is not necessary to drench the tree. That is a needless waste of material. Two or three gallons of the mixture are sufficient to thoroughly spray a fully grown apple tree. The important point is to get it evenly distributed.

Fourth. Unfortunately, it is impossible to give definite directions regarding the time to spray, because that varies with the locality, with the season, with the varieties to be sprayed, and with the pests for which one sprays. However, under the head of insects and diseases and in a spraying calendar appended to this bulletin we shall indicate the approximate times at which the principal sprays should be applied. It is well to remember, however, that spraying for the codling moth and for most fungus diseases is preventive and must be applied before the pest has made much appreciable headway. It is also well to remember that it is not best to spray trees when they are in blossom. It is not necessary, and it is not only liable to injure the blossoms but is certain to poison many of the fruit growers' best friends—the bees. Another point to be kept in mind is that the spraying *must be done at the proper time*. If done a few days too early or too late it is likely to be entirely useless, whereas the same application if made at the right time would have been entirely satisfactory. When the time for spraying comes nothing should be allowed to interfere with it. Even cloudy or rainy weather should not cause a delay for any considerable time because nearly all the mixtures, if well prepared, and if they have a short time to dry will remain upon the trees through several heavy showers. After long heavy rainstorms, however, it is usually necessary to repeat the application.

Fifth. There are, it is true, some pests that may be controlled by one or two sprayings, but the vast majority of the really serious enemies of our fruit trees require three, four, and perhaps five applications to keep them under perfect control. In general no one should expect to make less than three or four applications.

THE SPRAYING OUTFIT.

In order to apply any spraying mixture thoroughly and economically to every part of a tree, one must use a good pump and good nozzles. It is impossible to recommend any exact style of pump that is best for all purposes. If one has but a few trees to

spray almost any of the numerous styles of bucket pumps will answer the purpose. But for orchard work the pump should be large enough, and should have an air chamber sufficient to maintain a steady spray from several nozzles. All of its parts that come in contact with the liquid should be non-corrosive, it should be strongly built, simple in construction, easily taken apart for repairs and should have the pipes so arranged as to prevent clogging. It should be provided with an agitator which will keep the mixture well stirred and should be provided with couplings for at least two lines of hose. Several styles of pumps that will approximately meet the above requirements are upon the market and when mounted upon a suitable tank, and provided with two leads of hose, bamboo extension rods—for elevating the nozzles—and good nozzles, most of them will give good results. The best nozzle in our estimation is the Vermorel. For rapid work we prefer the double Vermorel and would select that form having a joint between the nozzle chamber and elbow to facilitate cleaning in case of clogging. The Vermorel nozzle throws a very finely divided spray and is suitable for nearly all purposes except the spraying of very tall trees. For such purpose some graduating nozzle like the McGowan is to be preferred. The form of tank, like the style of pump, depends upon the work to be done. If only a few trees are to be sprayed a small pump mounted on a barrel will make a convenient outfit, but if an orchard of any considerable size is to be sprayed the pump should be mounted upon some such tank as that shown in the accompanying plate—one that will hold 250 to 300 gallons of mixture. Such a tank will effect a saving in time, sufficient to more than cover its cost, in a single season. Steam spraying outfits are being introduced for use in large orchards and it is claimed for them that they are more economical than the hand power machines.

INSECTICIDES.

For all practical purposes insects may be divided into two great classes.

- a. Those that actually chew and swallow the tissue of the plant or its fruit.
- b. Those that pierce the surface of the plant with a long slender beak and suck up its juices, but eat none of the tissues.

To class "a" belong all caterpillars, beetles, slugs, codling moth, etc.

To class "b" belong the green aphis, the woolly aphis, the various scale insects, squash bugs, and other true bugs, the red spider, etc.

The injury caused by insects of class "a" is readily observed and hence is more apt to receive prompt attention, while on the other hand the injury caused by those of class "b," although no less severe, is often less noticeable. Hence it is that insects of this class, which injure the plant simply by appropriating its juices, thus causing the foliage to become spotted or yellow, and finally to wither and die, are allowed to multiply to such an extent that the most energetic measures are required for their control.

A brief consideration of the above facts regarding the general habits of insects, will serve to convince one that while most insects belonging to class "a" are readily destroyed by the poison sprays, on the other hand, insects belonging to class "b" are but little if at all affected by them, since they secure their food beneath the surface of the leaf and hence can not be made to eat any of the poison. It thus becomes necessary in order to successfully deal with these two classes of insects, to have two general classes of insecticides.

1st. The poisons, as Paris green and London purple, which are to be used against insects of class "a," but which are practically of no value against those of class "b."

2d. Those substances which kill by contact, as kerosene emulsion, the resin wash, the lime, salt, and sulphur mixture, whale-oil soap, lye, sulphur, etc., which are chiefly used against insects of class "b."

POISONS.

The chief insecticides of this class are Paris green and London purple. These are so well known that but few words concerning them are necessary. Paris green is, we think, undoubtedly the better of the two. It is more uniform in strength, kills more quickly, and is less liable to burn the foliage. London purple is slightly cheaper, and, being lighter, is more easily kept from settling to the bottom of the spraying tank. For use against the codling moth, caterpillars, and most other insects of class "a," apply either, in the form of a spray, using the following proportions:

SPRAY NO. 1.

Paris green or London purple.....	1 pound.
Unslaked lime.....	2 pounds.
Water	160 to 200 gallons.

Slake the lime and while it is slaking stir in the Paris green. Then strain the mixture through a coarse sieve or piece of burlap, and dilute with the required amount of water. The Paris green and water can be used in the above proportion without the addition of the lime, but it is much safer to add it since it precipitates the soluble arsenic compounds, and thus prevents injury to the foliage. This is especially true in spraying such tender foliage as that of the peach.

If at any time, it is desirable to spray at the same time with an insecticide and a fungicide, and such is usually the case, either of the above poisons may safely be added to the Bordeaux mixture—the lime in the latter preventing all injurious effects of the poison upon the foliage.

On account of the price and the fact that Paris green and London purple are generally supposed to be adulterated, we receive frequent requests for information regarding the feasibility of using arsenic—arsenious acid—as a substitute. For this reason the following formula is given with the warning that it be used with caution, since, if any of the arsenic remains in solution instead of being precipitated by boiling with the lime, it is liable to injure the foliage:

SPRAY NO. 1α.

White arsenic.....	1 pound.
Lime, unslaked.....	2 pounds.
Water..	3 gallons.

Boil together for at least an hour, and when ready for use dilute with 200 gallons of water, or preferably with Bordeaux mixture. We have used this preparation successfully but find that considerable care is necessary to prolong the boiling until all of the arsenious acid is precipitated as insoluable arsenite of lime.

CONTACT INSECTICIDES.

SPRAY NO. 2—KEROSENE EMULSION.

We consider this one of the best insecticides to use against insects of class "b." Kerosene kills by contact and its penetrating power is such that but few insects can resist it. The pure oil is,

however, about as injurious to plants as to insects, and thus it becomes necessary to emulsify it with some substance that it may readily be diluted with water. Soap or sour milk are the best of such substances. The emulsion with soap is made as follows:

Water.....	1 gallon.
Soap (preferably whale-oil soap).....	$\frac{1}{2}$ pound.
Kerosene oil.....	2 gallons.

Dissolve the soap in the water by boiling. Add the suds, still boiling hot, to the oil and violently agitate the mixture by pumping it back upon itself through a force pump. If hot, the emulsion should form in about five minutes, otherwise it may not emulsify at all without reheating. A perfect emulsion should have a creamy appearance, and should adhere to the surface of glass without oiliness. If not perfect, the oil will rise to the surface and much harm may result, especially if the emulsion is used as a dip for nursery stock or animals. Such an emulsion may be used immediately; or, if well made may be kept indefinitely as a stock mixture to be diluted and used as wanted.

When ready for use, dilute the required amount of stock emulsion with 8 to 15 or 20 times its bulk of water, and use as a spray. The stronger mixture applied in the fall, has been found effective in destroying the pear-leaf blister mite. The weaker will be found sufficiently strong to destroy the young of the oyster-shell scale, if applied to infested trees just after the blossoms fall, and will also prove effective in destroying green aphid, woolly aphid, and red spider, if applied at any time when they are observed to be abundant.

While recommending the above emulsions, I am well aware that, in the past, they have not been the favorite sprays with Oregon fruit growers, but I still believe that careful and more extensive use of properly made emulsions will yet demonstrate that they are among the best, if not the best washes we have for controlling the above mentioned class of insects.

One of the chief objections urged against these emulsions is their cost, and yet when we consider the ease with which they are made and their effectiveness, we must, notwithstanding the exorbitant price of kerosene oil, still number them among our cheapest effective washes. Two gallons of kerosene and one gallon of strong suds will, in process of emulsifying, increase in volume to about four gallons of stock emulsion, which when diluted with

water in the above indicated proportions will make from 32 to 80 gallons of spraying strength—the latter thus costing (at the present price of kerosene) from about $1\frac{1}{4}$ cents down to $\frac{1}{2}$ of a cent per gallon.

It is also urged against kerosene emulsion that it cannot be safely used in this climate—that it will kill the trees. My experience has been that it can be as safely used here as anywhere else. All that is necessary to safely use this remedy is to strictly follow directions in making the emulsion, dilute it as directed before applying it, and then *see that it does not run down the trunk of the tree and collect in the "cup" of earth about the crown.*

SPRAY NO. 3—RESIN WASH.

This is a favorite wash in California for several of the scales infesting citrous fruits. In this State its chief value is as a spray for the various kinds of plant lice. For this purpose it may be used as a substitute for kerosene emulsion with good results, particularly in the dry summer months. It can also be used as a summer spray for San Jose scale, but we do not advise such use since summer sprays are of but little value against this insect. The resin wash may be made as follows:

Resin	20 pounds.
Crude caustic soda (78 per cent.).....	5 pounds.
Fish oil	$2\frac{1}{2}$ pints.
Water to make.....	100 gallons.

Place the resin, soda, and oil in a kettle with sufficient water to cover them to a depth of three or four inches. Boil about two hours, making occasional additions of water, or until the compound resembles very strong black coffee. Dilute to one-third the final bulk with hot water, or with cold water added slowly over the fire, making a stock mixture which must be diluted to the full amount of 100 gallons when ready for use.

SPRAY NO. 4—LIME, SULPHUR AND SALT.

This is a winter wash and is by far the most satisfactory remedy for the San Jose scale that we have tested. It should never be applied to trees after the buds have opened in spring.

Several methods of preparing it are in use, but the formula that seems to give the best results is based upon the extensive experience of Mr. Emile Schanno, Horticultural Commissioner for the Fourth District. It is as follows:

Lime (unslaked).....	50 pounds.
Sulphur.....	50 pounds.
Salt.....	50 pounds.
Water.....	150 gallons.

Slake the lime, add the sulphur, cover with water and boil briskly for at least one hour, or until the lime and sulphur are completely dissolved. Then add the salt and continue to boil for fifteen or twenty minutes. When ready for use dilute to one hundred and fifty gallons.

The best results are obtained with this wash if it is applied, while still warm, with considerable force in the form of a coarse spray.

A mixture somewhat similar to the above is made by using seven or eight pounds of copper sulphate in place of the fifty pounds of salt. It originated in the work of the State Board of Horticulture and gives most excellent results when used as a winter spray.

Both of the above mixtures are difficult to properly prepare and unless one has ample facilities for the work greater satisfaction will be obtained by purchasing the prepared sprays than by attempting to make them oneself. The lime, sulphur and salt is sold as Spray No. 1, and the lime, sulphur and copper sulphate as Spray No. 2, by David M. Dunn & Co., Portland, Oregon.

SPRAY NO. 5—BORDEAUX MIXTURE.

This is perhaps the most generally useful of all the spraying mixtures. It is the principal remedy for fungus diseases, and also has some value as an insecticide. It also has a beneficial effect upon plants which is independent of its effect upon fungus and insect parasites, and is the best medium in which to apply Paris green or London purple. In fact, had it no value as a fungicide or insecticide, I am strongly of the opinion that its beneficial effect upon plants and its value as a medium in which to apply the arsenites would justify me in recommending that *bordeaux mixture be made the basis of all sprays containing the arsenites. i. e., bordeaux mixture should be used instead of pure water in preparing Spray No. 1.*

Bordeaux mixture is ordinarily made as follows:

Copper sulphate.....	6 pounds.
Lime (unslaked).....	4-6 pounds.
Water....	50 gallons.

For winter spraying in those portions of the State that have excessive rainfall it has been found best to use eight to ten pounds of lime.

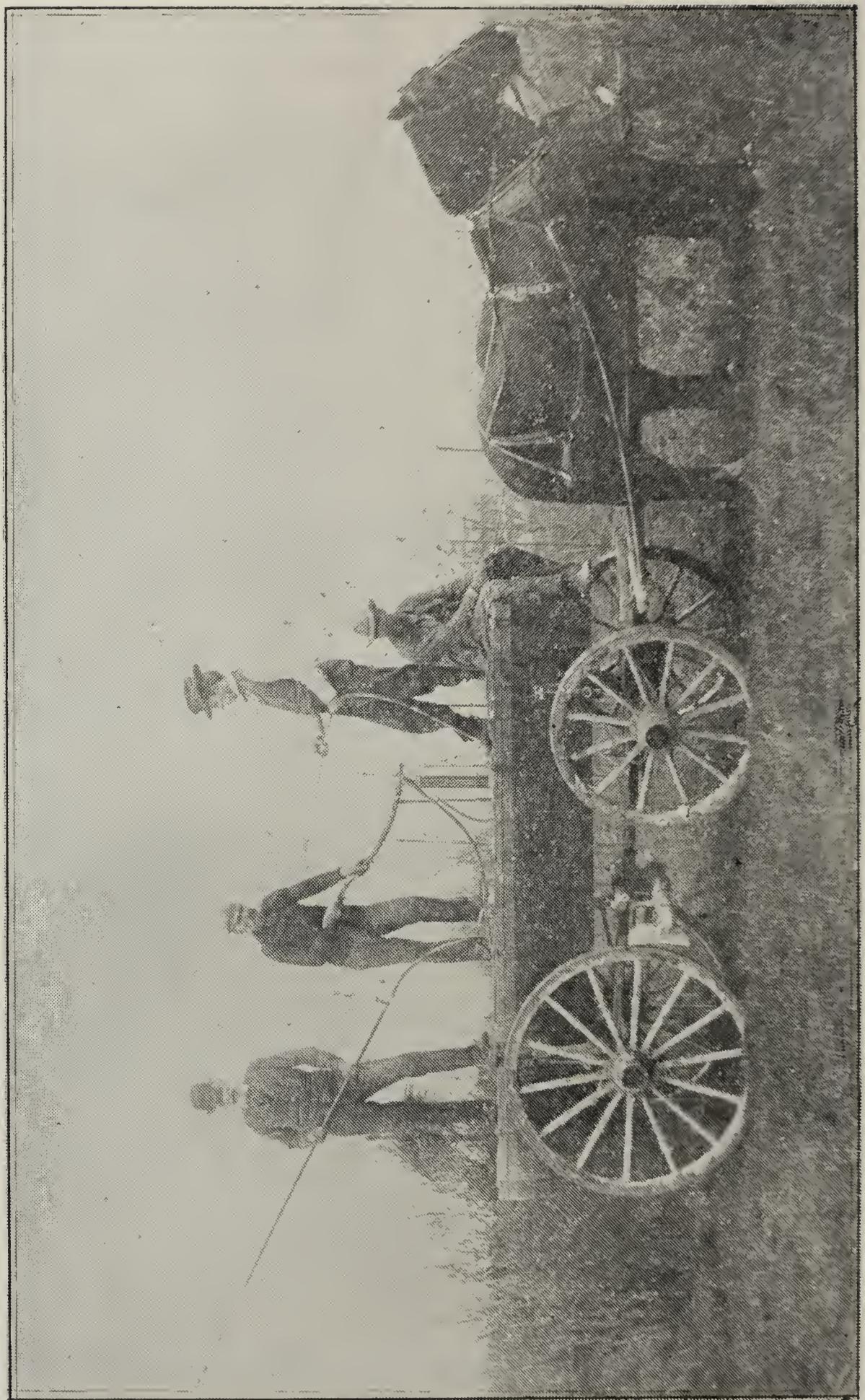
So much depends upon the correct preparation of bordeaux mixture that we quote in full the directions for its preparation which are given by Dr. Galloway of the United States Department of Agriculture:

"It has been found that the method of combining the ingredients has an important bearing on both the chemical composition and physical structure of the mixture. For example, if the copper sulphate is dissolved in a small quantity of water and the lime milk diluted to a limited extent only, there results, when these materials are brought together, a thick mixture, having strikingly different characters from one made by pouring together weak solutions of lime and copper sulphate. It is true, furthermore, that if the copper sulphate solution and lime milk are poured together while the latter or both are warm, different effects are obtained than if both solutions are cool at the moment of mixing.

"Briefly, the best results have been obtained from the use of the bordeaux mixture made in accordance with the following directions: In a barrel or other suitable vessel place 25 gallons of water. Weigh out 6 pounds of copper sulphate, then tie the same in a piece of coarse gunny sack and suspend it just beneath the surface of the water. By tying the bag to a stick laid across the top of the barrel no further attention will be required. In another vessel slack 4 pounds of lime, using care in order to obtain a smooth paste, free from grit and small lumps. To accomplish this it is best to place the lime in an ordinary water pail and add only a small quantity of water at first, say a quart or a quart and a half. When the lime begins to crack and crumble and the water to disappear add another quart or more, exercising care that the lime at no time gets too dry. Toward the last considerable water will be required, but if added carefully and slowly a perfectly smooth paste will be obtained, provided, of course, the lime is of good quality. When the lime is slacked add sufficient water to the paste to bring the whole up to 25 gallons. When the copper sulphate is entirely dissolved and the lime is cool, pour the lime milk and copper sulphate solution slowly together into a barrel holding 50 gallons. The milk of lime should be thoroughly stirred before pouring. The method described insures good mixing, but to complete this work the barrel of liquid should receive final stirring, for at least three minutes, with a broad wooden paddle.

"It is now necessary to determine whether the mixture is perfect--that is, if it will be safe to apply it to tender foliage. To

COLLEGE SPRAVING OUTFIT.



accomplish this, two simple tests may be used. First insert the blade of a penknife in the mixture, allowing it to remain there for at least one minute. If metallic copper forms on the blade, or, in other words, if the polished surface of the steel assumes the color of copper plate, the mixture is unsafe and more lime must be added. If, on the other hand, the blade of the knife remains unchanged, it is safe to conclude that the mixture is as perfect as it can be made. As an additional test, however, some of the mixture may be poured into an old plate or saucer, and while held between the eyes and the light the breath should be gently blown upon the liquid for at least half a minute. If the mixture is properly made, a thin pellicle, looking like oil on water, will begin to form on the surface of the liquid. If no pellicle forms, more milk of lime should be added.

"The foregoing directions apply to cases where small quantities of the mixture are needed for more or less immediate use. If spraying is to be done upon a large scale, it will be found much more convenient and economical in every way to prepare what are known as stock solutions of both the copper and lime. To prepare a stock solution of copper sulphate, procure a barrel holding 50 gallons. Weigh out 100 pounds of copper sulphate, and after tying it in a sack suspend it so that it will hang as near the top of the barrel as possible. Fill the barrel with water, and in two or three days the copper will be dissolved.

"Now remove the sack and add enough water to bring the solution again up to the 50 gallon mark, previously made on the barrel. It will be understood, of course, that this second adding of water is merely to replace the space previously occupied by the sack and the crystals of copper sulphate. Each gallon of the solution thus made will contain 2 pounds of copper sulphate, and, under all ordinary conditions of temperature, there will be no material recrystallization, so that the stock preparation may be kept indefinitely.

"Stock lime may be prepared in much the same way as the copper sulphate solution. Procure a barrel holding 50 gallons, making a mark to indicate the 50 gallon point. Weigh out 100 pounds of fresh lime, place it in the barrel and slack it. When slacked add sufficient water to bring the whole mass up to 50 gallons. Each gallon of this preparation contains, after thorough stirring, 2 pounds of lime.

"When it is desired to make bordeaux of the 50 gallon formula it is only necessary to measure out 3 gallons of the stock copper solution, and, after thorough stirring, 2 gallons of the stock lime; dilute each to 25 gallons, mix, stir, and test as already described. One test will be sufficient in this case. In other words, it will not be necessary to test each lot of bordeaux mixture made from the stock preparation, provided the first lot is perfect, and no change is made in the quantities of the materials used. Special

care should be taken to see that the lime milk is stirred thoroughly each time before applying. As a final precaution it will be well to keep both the stock copper sulphate and the stock lime tightly covered."

SPRAY NO. 6—AMMONIACAL SOLUTION OF COPPER CARBONATE.

Bordeaux mixture is the most generally useful of all fungicidal mixtures, but for spraying fruits that are nearly mature the ammoniacal solution of copper carbonate is usually preferred. It is prepared as follows:

Copper carbonate.....	5 ounces.
Strong aqua ammonia	3 pints.
Water.....	45 gallons.

The copper carbonate is first mixed into a thin paste with a little water, and then the ammonia is added. The result is a clear deep blue solution which is then to be diluted with the 45 gallons of water. *Paris green or London purple must not be added to this mixture.*

Sprays and Spray Calendar for Treatment of Some of the Most Important Pests.

APPLES AND PEARS.

For codling moth, apple scab and all leaf eating insects: First, apply spray No. 5 before the buds open. Second, spray with No. 5 plus Paris green (See page 15) after the blossoms fall and *before the calyx closes.* Third, the same as second, but ten days to two weeks later. Fourth, use spray No. 1 at intervals of about two weeks until fruit begins to ripen. Fifth, the sprays should be supplemented by rapid destruction of all fallen fruit, and by screens in the windows of storerooms in which apples are kept, and may be further supplemented by banding the trees with burlaps and killing the larvæ and pupae that congregate under the bands.

For San Jose scale: Spray thoroughly with No. 4 in winter.

For woolly aphid on branches: Spray thoroughly with No. 4 in winter. If necessary supplement this with summer sprays No. 2, or No. 3.

For green aphid: To destroy eggs spray in winter with No. 4. If necessary supplement this by thoroughly underspraying infested leaves in summer with No. 2, or No. 3.

For tingis: Thoroughly underspray infested leaves with No. 2, or No. 3.

For canker: Spray early in August and again in October with No. 5. If fruit is on the trees use spray No. 6 instead.

PRUNES.

For shot-hole fungus: First, spray with No. 5 ten days after the blossoms fall. Second, repeat in about two weeks. Third, repeat again in about two weeks.

For brown rot: If the brown rot was present in the orchard last season the above sprayings should be supplemented by an additional application of No. 5, before the buds open, and if the ripening period is preceded by moist warm weather one or two applications of No. 6 may be necessary to save the crop. All refuse fruit on the trees or ground should also be destroyed.

For twig borer: If this troublesome pest is present Paris green should be added to No. 5 for the first three applications recommended for brown rot.

For San Jose scale: See under Apples and Pears.

CHERRIES.

For shot-hole fungus: See under Prunes.

For brown rot: See under Prunes.

For cherry slugs and other leaf-eating insects: Spray at beginning of injury with No. 1. If fruit is ripening use Hellebore, 1 ounce to 2 gallons of water.

For San Jose scale: See under Apples and Pears.

The Entomologist of the Station is pleased at all times to receive specimens of injurious insects and parts of infested plants, and will so far as possible give directions for curing or preventing the injury. Specimens should not be sent in letters but in pasteboard or tin boxes.

A. B. CORDLEY.

LIST OF BULLETINS

Published by the Oregon Agricultural Experiment Station to December 31, 1897.

*No. 1, 1888—History and Organization .....	.....	.....	.....	Grimm.
*No. 2, 1889—Horticulture.....	.....	.....	.....	Lake
*No. 3, 1889—Entomology and Chemistry .....	.....	.....	.....	Washburn
*No. 4, 1890—Agriculture, Horticulture, Chemistry.....	.....	.....	.....	.....
*No. 5, 1890—Chemistry, Entomology, Zoology .....	.....	.....	.....	Irish and Washburn.
No. 6, 1890—Chemistry, Zoology .....	.....	.....	.....	Washburn.
No. 7, 1890—Small Fruits and Vegetables.....	.....	.....	.....	Coote.
No. 8, 1891—Varieties of Wheat and Flax .....	.....	.....	.....	French.
*No. 9, 1891—Silos and Silage .....	.....	.....	.....	French.
No. 10, 1891—Entomology.....	.....	.....	.....	Washburn.
*No. 11, 1891—Grasses and Potatoes.....	.....	.....	.....	French.
*No. 12, 1891—Strawberries.....	.....	.....	.....	Coote.
*No. 13, 1891—Chemistry .....	.....	.....	.....	Shaw.
*No. 14, 1891—Entomology.....	.....	.....	.....	Washburn.
*No. 15, 1892—Horticulture .....	.....	.....	.....	Coote.
*No. 16, 1892—Varieties of Wheat .....	.....	.....	.....	French.
*No. 17, 1892—Sugar Beets .....	.....	.....	.....	Shaw.
*No. 18, 1892—Entomology.....	.....	.....	.....	Washburn.
*No. 19, 1892—Oregon Weeds .....	.....	.....	.....	Craig.
*No. 20, 1892—Pig Feeding.....	.....	.....	.....	French.
*No. 21, 1892—Soils of Oregon .....	.....	.....	.....	Shaw
*No. 22, 1893—Horticultural Department...	.....	.....	.....	Coote.
*No. 23, 1893—Sugar Beets in Oregon .....	.....	.....	.....	Shaw.
*No. 24, 1893—Potatoes and Roots .....	.....	.....	.....	French.
*No. 25, 1893—Codlin Moth, Hop Louse .....	.....	.....	.....	Washburn.
*No. 26, 1893—Drainage.....	.....	.....	.....	Bloss.
No. 27, 1893—Plant Diseases, etc...	.....	.....	.....	Craig.
No. 28, 1894—Pig Feeding, continued....	.....	.....	.....	French.
No. 29, 1894—Horticulture, Pruning, etc.....	.....	.....	.....	Coote..
No. 30, 1894—Potatoes and Roots, continued .....	.....	.....	.....	French.
No. 31, 1894—Codlin Moth, Hop Louse .....	.....	.....	.....	Washburn.
No. 32, 1894—Five Farmers' Foes.....	.....	.....	.....	Craig.
No. 33, 1894—Tent Caterpillar.....	.....	.....	.....	Washburn.
No. 34, 1895—Fruits and Vegetables....	.....	.....	.....	Coote.
No. 35, 1895—Pig Feeding, continued .....	.....	.....	.....	French.
No. 36, 1895—Composition and Use of Fertilizers...	.....	.....	.....	Shaw.
No. 37, 1895—Experiments in Cattle Feeding .....	.....	.....	.....	French.
No. 38, 1895—Fruit Pests .....	.....	.....	.....	Washburn.
No. 39, 1895—Grasses, Chemistry .....	.....	.....	.....	Shaw.
No. 40, 1896—Prunes, Apples and Pears .....	.....	.....	.....	Hedrick.
*No. 41, 1896—Spraying .....	.....	.....	.....	Hedrick and Cordley.
No. 42, 1896—Feeding Sheaf Wheat.....	.....	.....	.....	French.
No. 43, 1897—Flax Culture.....	.....	.....	.....	French.
No. 44, 1897—Oregon Sugar Beets.....	.....	.....	.....	Shaw.
No. 45, 1897—Prunes in Oregon...	.....	.....	.....	Hedrick, Cordley and Shaw.
*No. 46, 1897—Cicuta.....	.....	.....	.....	Hedrick.
No. 47, 1897—Cheat and Clover...	.....	.....	.....	Shaw and French.
No. 48, 1898—Spraying.....	.....	.....	.....	Cordley.
No. 49, 1898—Paris Green .....	.....	.....	.....	Shaw.
Circular No. 1—Dairying in Oregon.....	.....	.....	.....	Shaw, French and Kent.

Copies will be sent to applicants so long as the supply lasts. Those designated by an asterisk (*) are already exhausted.

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